WHAT IS CLAIMED IS:

1. In an input/output (I/O) system of a programmable controller, a communications method and I/O circuit for exchanging information on control and operating parameters between a controlling element of the I/O system and a controlled element thereof which includes an output control device activated and deactivated in accordance with the control information, comprising the steps of:

a) generating in the controlling element a control signal in the form of sequential pulse frames, each frame having at least one control pulse defining said control information;

b) transmitting said control signal to said controlled element and generating in the controlled element a clock pulse for each control pulse such that said clock pulse follows said control pulse by a pre-selected time interval on each frame, there being one clock pulse for each control pulse such that there is a fixed time relationship between each control pulse and each clock pulse;

c) generating in the controlled element a diagnostic signal independent of the control signal but which is indicative of operating parameters of the controlled element; and

d) using said clock pulse on each frame to cause a sampling of said control information and to cause a transmission of a value of said diagnostic signal to said controlling element;

wherein the I/O circuit comprises a switch processor, a plurality of signal conditioning circuits, and a switch section.

2. The method of claim 1 wherein each frame of the control signal further includes a no-pulse time interval during which no pulses appear defining the end of a frame.

3. The method of claim 2 wherein each frame of said control signal includes a series of pulses defining said control information.

4. The method of claim 3 wherein the series of pulses comprises two to six pulses, followed by the no-pulse time interval.

5. The method of claim 4 wherein the no-pulse time interval comprises a missing pulse for synchronizing the control and diagnostic signals.

6. The method of claim 4, wherein a first two of the two to six pulses are redundant pulses representing an ON/OFF command.

7. The method of claim 6, wherein a third and fourth of said two to six pulses comprise control information.

8. The method of claim 7, wherein a fifth and sixth of said two to six pulses comprise diagnostic information.

9. The method of claim 3 wherein said series of pulses is pulse width modulated.

10. The method of claim 9 wherein said diagnostic signal comprises a multi-bit digital signal and the number of bits transmitted to said controlling element on each frame equals the number of pulses in said series of pulses in the same frame, and wherein the multi-bit digital signal is determined by firmware loaded on the switch processor.

11. An input/output (I/O) circuit comprising a switch processor, a plurality of signal conditioning circuits, and a switch, wherein the switch processor comprises firmware programmed to accept signals from the signal conditioning circuits and a microcontroller as data inputs, and to act upon the information contained in those inputs to control the switch and provide diagnostic information to the microcontroller.

12. The circuit of claim 11, wherein the signals accepted as inputs to the firmware comprise a series of two to six pulses.

13. The circuit of claim 12, wherein the switch processor comprises a zero crossing turn-on and turn-off feature, wherein the switch processor waits until a zero crossing of voltage before turning the switch section on, and a zero crossing of current before turning the switch section off .

14. The circuit of claim 11, wherein the switch processor comprises an analog-to-digital converter circuit for converting signals to a form usable by the firmware.

15. The circuit of claim 14, wherein the switch processor receives a signal representative of the switch section current.

16. The circuit of claim 15, wherein the switch processor causes the switch to be turned off immediately upon detection of a first threshold current level.

17. The circuit of claim 16, wherein the switch processor causes the switch to be turned off after a predetermined period of time during which the switch processor detects a switch current level of a second threshold level, the second threshold level being lower than the first threshold level.

18. The circuit of claim 17, wherein the switch processor reports an overcurrent diagnostic signal, but does not turn off the switch, upon detection of a switch current level of a third threshold level, the third threshold level being lower than the second threshold level.

19. The circuit of claim 11, wherein the firmware of the switch processor generates diagnostic codes for one or more of: over temperature conditions, short circuit conditions, over current conditions, low voltage conditions, and high voltage conditions based on input signals from the conditioning circuits.

20. In an input/output (I/O) system of a programmable controller, an input/output mode comprising :

an operations control unit including a switch processor for providing a control signal in the form of sequential pulse frames, each frame having at least one control pulse defining a desired control status; and

at least one I/O point connected to the operations control unit and having an output control device subject to activation and deactivation as an operative condition in accordance with said control status and further including: (1) timing means responsive to each control pulse to generate a clock pulse which follows said control pulse by a pre-selected time interval on each frame, there being one clock pulse for each control pulse such that there if a fixed time relationship between such pulses; (2) firmware located on the switch processor and connected to the I/O point for providing a diagnostic signal having a value indicative of the operative condition of the I/O point; (3) means connected to receive each clock pulse and responsive to each clock pulse on each frame to cause a sampling of each control pulse to determine the desired control status; and (4) means connected to receive each clock pulse and the diagnostic signal and responsive to said

clock pulse on each frame to cause a transmission of a value of said diagnostic signal to the operations control unit.

21. The input/output module of claim 20 wherein said operations control unit provides said control signal such that each frame includes a series of pulses followed by a no-pulse time interval during which no pulses occur, said no-pulse time interval defining the end of a frame.

22. The input/output module of claim 21 wherein at least the first two pulses of each frame are pulse width modulated redundantly to determine the control status.

23. In a programmable controller input/output system of the type having a plurality of input/output modules, each adapted to be located in proximity to a process being controlled, circuitry for use in such modules, comprising:

output control means responsive to be activated and deactivated by a command signal;

an operations controller generating at least one control signal in the form of sequential pulse frames, each frame of which contains at least one pulse defining a control status for the output control means and a time interval without pulses defining the end of the frame whenever said interval reaches a first pre-selected time duration;

a communications and control section receiving said control signal and including firmware responsive to said at least one pulse to provide said command signal for activating and deactivating said output control means in accordance with said control status for each frame and means responsive to said time interval for synchronizing operation of said communications and control section with each frame; sensing means providing status signals indicative of the operative condition of said output control means; and wherein said communications and control section includes a switch processor with

on-board firmware coding for receiving said status signals and responsive thereto to produce a diagnostic signal which is updated on each frame of said control signal and first selector means for transmitting said diagnostic signal to said operations controller on each frame of said control signal.

24. The circuitry of claim 23 wherein each frame of said control signal contains a series of pulses defining said control status.

25. The circuitry of claim 24 wherein at least the first two pulses of each frame are pulse width modulated redundantly to determine the command signal for activating and deactivating the output control means.

26. The circuitry of claim 25 wherein said communications and control section further includes second selector means responsive to said time interval to cause said output control means to assume a pre-selected state whenever the time duration of said interval reaches a second pre-selected value.

27. The circuitry of claim 26 further including a plurality of output control means and a corresponding plurality of communications and control sections, and wherein said operations controller generates a plurality of control signals providing one control signal for each communications and control section.